Offshore R&D Overview and Subcontracts

Walt Musial
National Renewable Energy Laboratory

FY2005 DOE Wind Program Implementation Meeting
November 16-18, 2004
Omni Interlocken Hotel
Broomfield, Colorado

U.S. Department of Energy Wind & Hydropower Technologies Program

Sandia National Laboratories

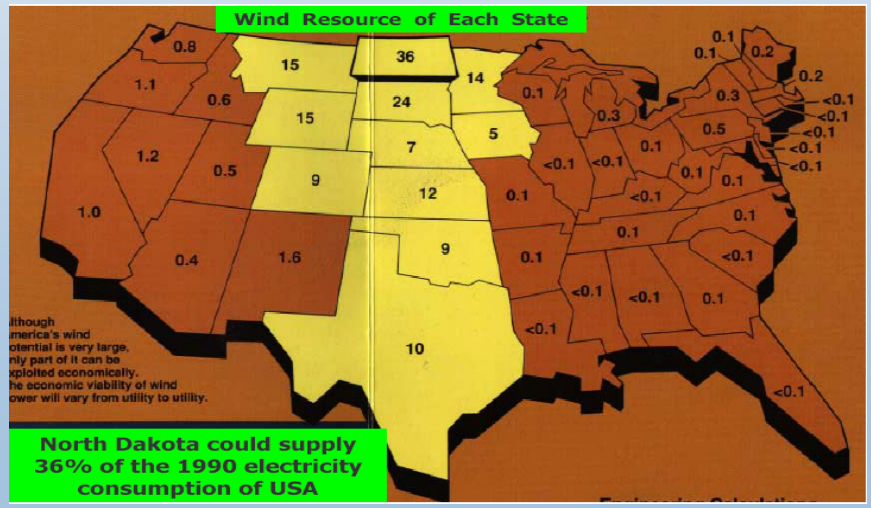
US Wind Resource – Land and Sea?

Large Land-based Potential for US

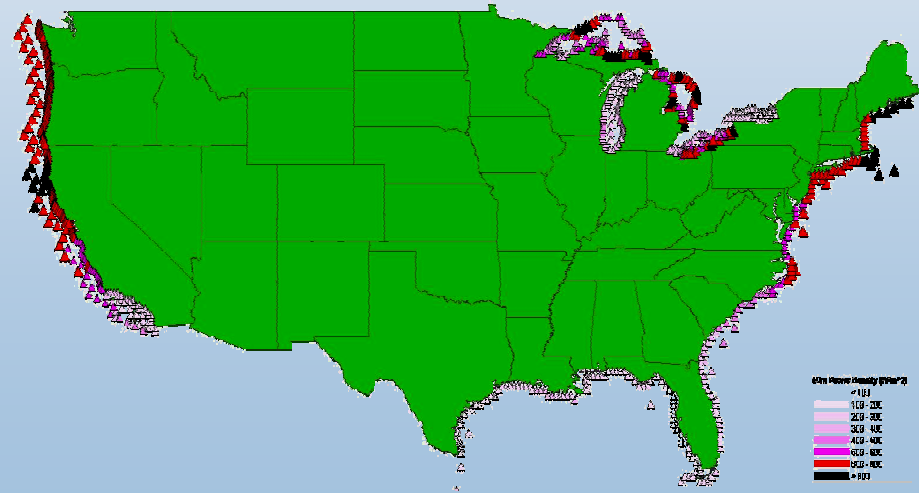
Windy land is not always near load centers

Grid is not set up for long inter-state electric transmission.

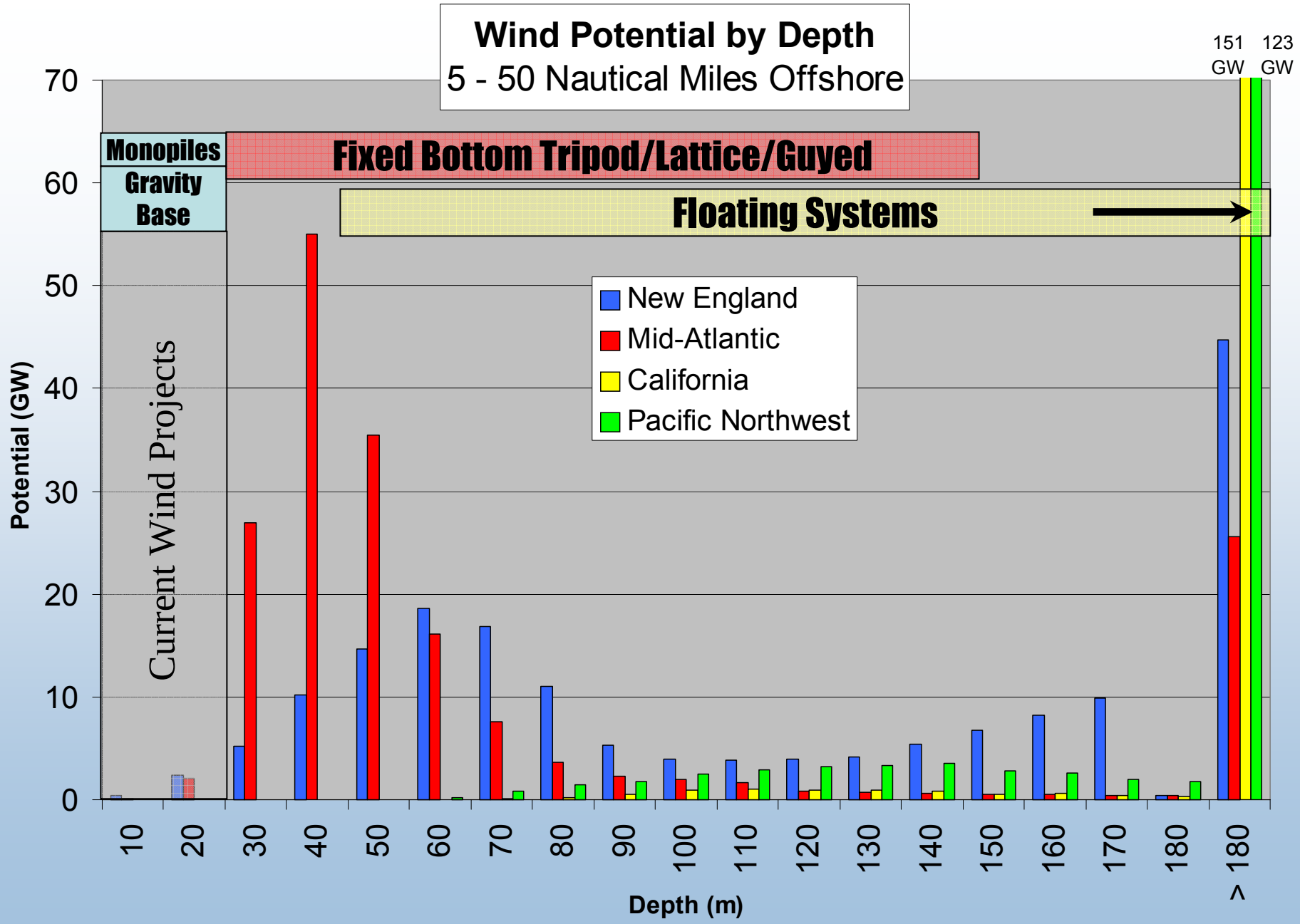
Offshore Wind May Be the Best Option in Many Cases



Onshore potential



Offshore potential


Wind Potential by Depth
5 - 50 Nautical Miles Offshore
151 GW
123 GW
Monopiles
Gravity Base
Fixed Bottom Tripod/Lattice/Guyed
Floating Systems
New England
Mid-Atlantic
California
Pacific Northwest
Current Wind Projects
Potential (GW)
0
10
20
30
40
50
60
70
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
> 180
Depth (m)

DOE/NREL FY05 Offshore Wind Activities

LWST Subcontracts - $10.6M – NREL $0.8M – Other $$0.3M

LWST Offshore Wind Development - $255K

- Deepwater Workshops
- IEA Offshore Annex 23
- Deepwater Technology R&D
- Technology Characterization – COE Modeling
- Offshore Standards Development – IEC 61400-03

Offshore Wind Energy Collaborative (OWEC) - $100K

Offshore Wind Resource Assessment $400K

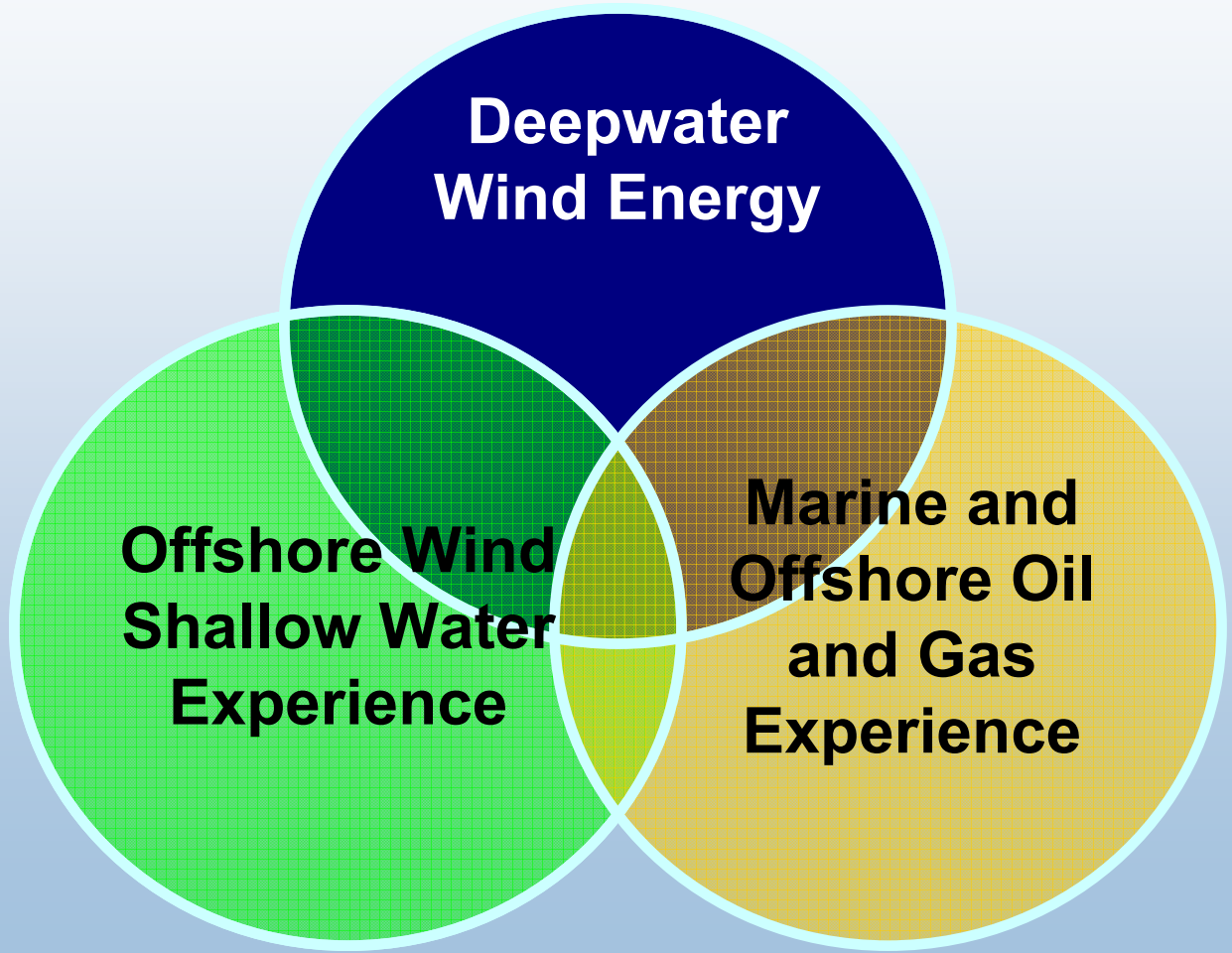
Low Wind Speed Technology, Phase II Subcontracts - $10.6M
LWST Offshore Project Management $145K

Ecological and Permitting Issues (Energetics) $200K

Offshore FY05 Milestones

- **Hold Offshore Deep Water Workshop (Complete)** — **Oct 04**
- **Award subcontract(s) for mapping offshore wind region(s)** — **Jun 05**
- **Complete design study and paper on offshore floating platforms** — **Sep 05**

Deepwater Wind Energy Workshops
Washington DC Oct 15-15, 2003
Washington DC Oct 26-27, 2004



Strategy

Identify technology gaps that must be filled in the next 10-15 years to achieve a mature offshore wind industry in the US

•Bring together industries that have experience and expertise in deepwater and marine applications.

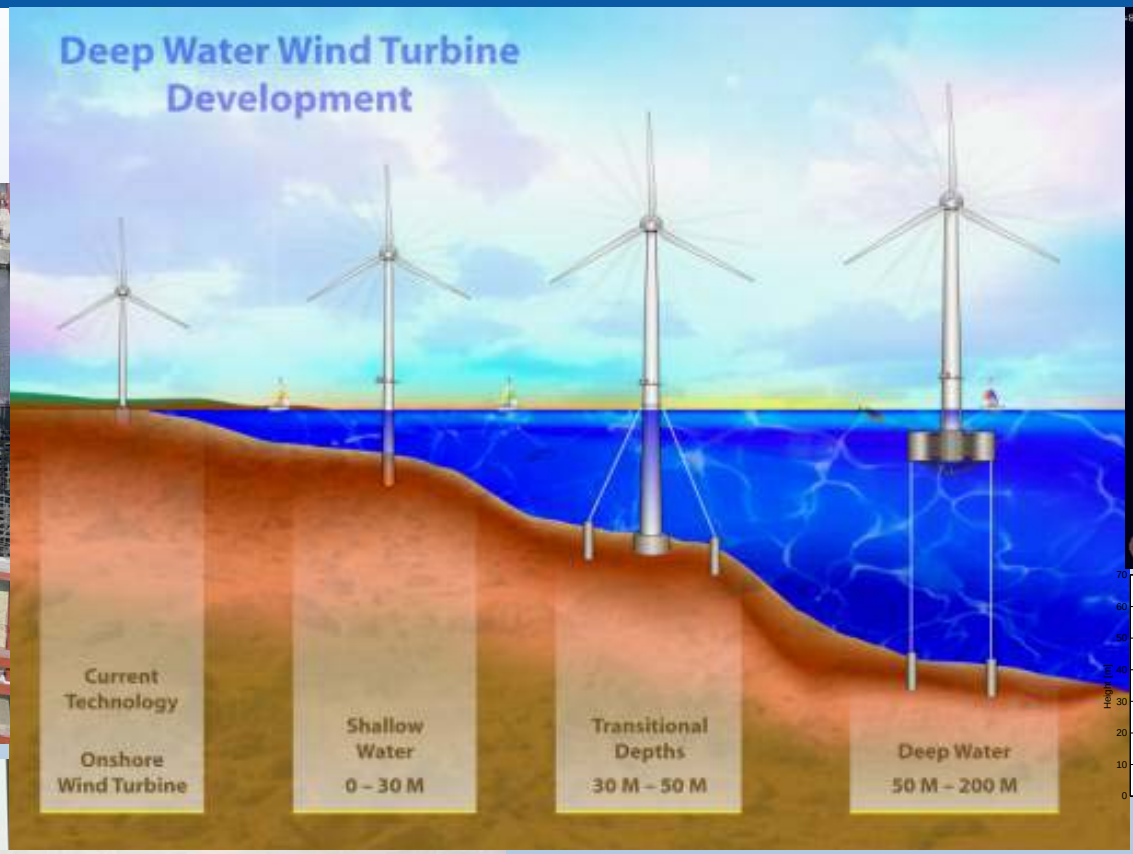
Deepwater Wind Energy Workshops Research Priorities

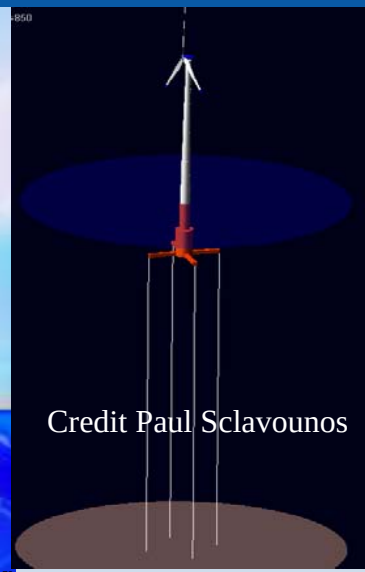
- Establish a design basis for a deepwater offshore turbine.
- Perform turbine/substructure system optimizations.
- Develop strategies to minimize work done at sea.
- Develop low-cost anchor system concepts.
- Deepwater site characterization methods.
- Conduct research on novel wind turbine technologies.

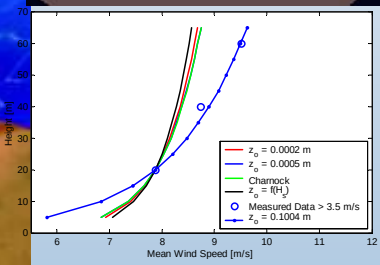
International Energy Agency Offshore Annex XXIII

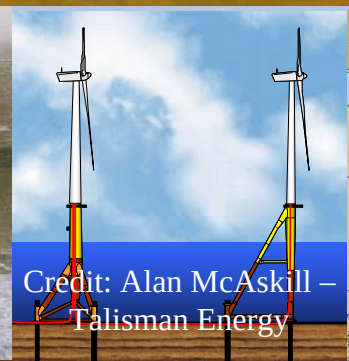
- IEA Topical Experts Meeting #43 held in Denmark ***"Critical Issues Regarding Offshore Technology and Deployment"***March 2004.
- United States (NREL/DOE) proposed a new annex (23) offshore issues ***"Offshore Wind Energy Technology and Deployment"***
- **IEA Annex XXIII** was approved in May 2004 by the IEA Executive Committee.
  - **Subtask #1 – "*Offshore Wind – Experience With Critical Deployment Issues"*** - Operating Agent - Denmark/RISO
  - ***Subtask #2 – "Offshore Wind – Technical Research For Deeper Water (> 30m)"*** – *Operating Agent* - U.S./NREL
- First Meeting for Subtask 2 – Washington DC October 28, 2004.
- Participants – US, Denmark, UK, Japan, Norway
- Collaborative Research Topic ***"Coupled Turbine/Substructure Dynamic Modelling"***
- Next Meeting January12-13, 2005 – Hosted by Denmark

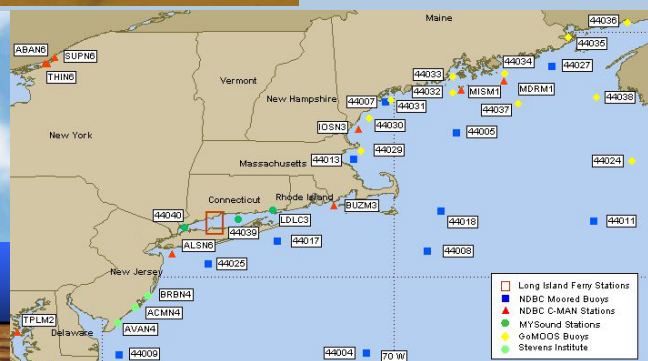
Deepwater Technology R&D











LWST Offshore Wind Development

- **Technology Characterization**
  - Cost of energy analysis and modeling (PERI)
  - National Energy Management System (NEMS) energy market analysis
  - Offshore Technology Improvement Opportunities (TIO)
  - WinDS modeling
- **Offshore Standards Development**
  - Support Development of IEC 61400-03

LWST Phase II – Subcontracts $10.6M

$145K Offshore Project Management

- AWS Truewind LLC – $200k Co-funded Concept Study
- Concept Marine Associates - $200k Concept Study
- Massachusetts Institute of Technology - $200k Concept Study
- GE Global Research – Offshore Full System ($8M NREL)
- GE Global Research – $4M Offshore Blade Component ($2M Sandia)

GE Global Research

LWST System Development Subcontract

"Multi-megawatt Offshore System Development"

- PI's Sumit Bose, Mohamed Ali, Bill Holley, Keith White
- $8M DOE Funding (21%)
- Subcontract under negotiation.
- Expected Award – 2nd Quarter 05.
- Scheduled Completion – FY09.
- 4 Phases
  - I - Planning and Preliminary Design
  - II- Detailed and Final Design
  - III- Prototype Fabrication
  - IV- Prototype Installation and Testing
- Turbine Design will Optimize Turbine Configuration for Offshore.

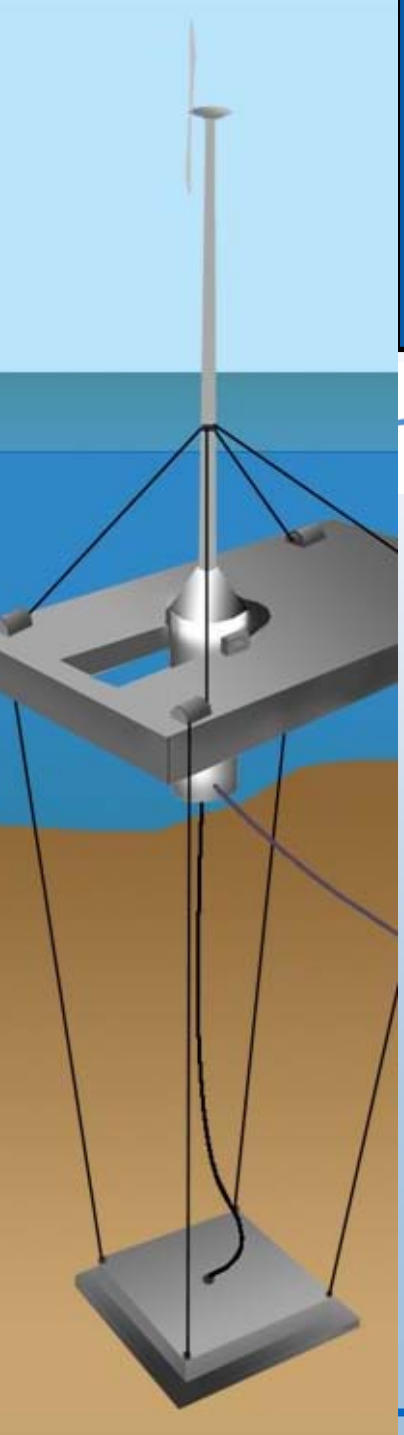
AWS Truewind LLC LWST Concept Study

"Development of Atmospheric Profiling and Modeling Techniques To Evaluate the Design and Operating Environment of Offshore Wind Turbines In the Mid-Atlantic and Lower Great Lakes"

- PI – Bruce Bailey
- Funding $600K DOE/NREL, NYSERDA, LIPA ($200K each)
- Kickoff meeting held Sept 9, 2004 in NY.
- Project Completion by Dec 2005.

Technical Tasks:

- Assimilation of existing coastal and marine climate data.
- Collection of new wind and wave data
- Verification and improvement of atmospheric and wave models.
- Conceptual development of buoy-mounted atmospheric profiling system



Concept Marine Associates (CMA)

LWST Concept Study

"Semi-Submersible Platform and Anchor Foundation Systems for Wind Turbine Support"

GEC
GLOBAL ENERGY CONCEPTS
THE Wind Resource

CMA

GARRAD HASSAN

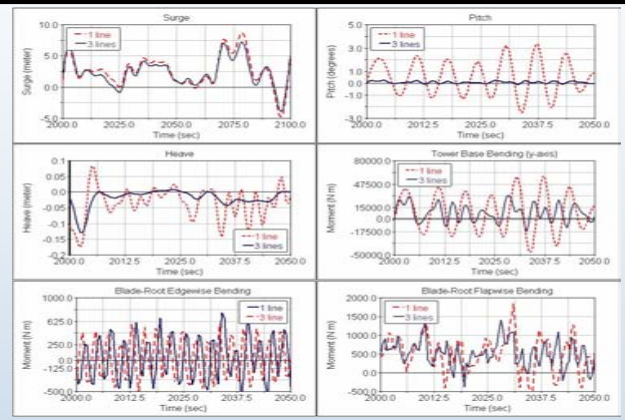
- PI's – Gordon Fulton, Chuck Garrison
- $200k NREL Funding
- Estimated Completion – April 2005.
- Kickoff Meeting November 10, 2004
- Objective:Develop cost model for a TLP platform to enhance COE analysis.
- Technology Benefits:
  - Concepts for minimizing work at sea.
  - Concrete construction and mass-production techniques.
  - Port access and construction issues.
  - Code development for coupled turbine platform systems.

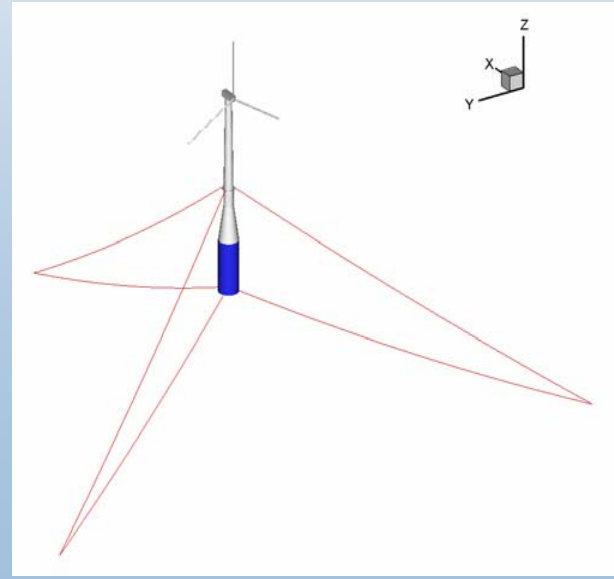
Massachusetts Institute of Technology (MIT)

LWST Concept Study

"Offshore Floating Wind Turbine Concepts: Fully Coupled Dynamic Response Simulations"

- PI – Dr. Paul Sclavounos
- $200k NREL Funding
- Estimated Completion Jan 2006.
- Kickoff Meeting Held Sept 2004
- Primary Objective: Code Development and Validation for Floating Wind Turbine Systems.
- Tasks:
  - Evaluation of Two Floating Concepts in Water Depths 100-200m
  - Optimization of Floater Configuration
  - Establish Analysis Steps for System Certification.
  - Perform Wind Farm Optimization Analysis
  - Perform Wind Farm Lifetime Economic Analysis.

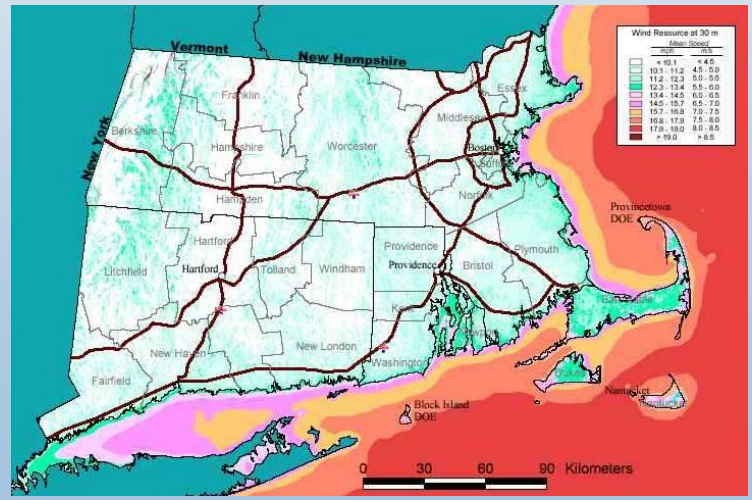




Offshore Wind Energy Collaborative (OWEC)

- Initiated by the Massachusetts Technology Collaborative (MTC).
- Funding Partners (DOE/NREL, GE Wind, Massachusetts Technology Collaborative)
- Pilot Research Projects – UMASS, MIT, WHOI
- DOE contribution $100K (total budget ~$600K)
- Roadmap process in progress

MASSACHUSETTS TECHNOLOGY COLLABORATIVE



Deepwater Wind Energy Technology Conclusions

- No Major Technology Breakthroughs Are Needed.
- Offshore Structures Can Survive at Sea Using Today's Technology.
- **The Issue Is Economics**.
- R&D Is Needed to Lower Costs and Demonstrate Reliability.
- Environmental and Permitting Issues Will Be a Factor.
- Deep Water Systems Can Be Feasible in 10 to 15 Years.